DOCUMENT RESUME

ED 386 851 EC 304 240

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TITLE	Research Synthesis on Design of Effective Media, Materials and Technology for Deaf and Hard-of-Hearing Students. Executive Summary. Technical Report No. 2.
INSTITUTION	National Center To Improve the Tools of Educators, Eugene, OR.; Oregon Univ., Eugene. Coll. of Education.
SPONS AGENCY	Special Education Programs (ED/OSERS), Washington, DC.
PUB DATE	29 Dec 93
NOTE	15p.; For full report, see EC 304 239.
PUB TYPE	Information Analyses (070)
EDRS PRICE	MF01/PC01 Plus Postage.
DESCRIPTORS	*Access to Education; Assistive Devices (for Disabled); Deafness; *Educational Media; Educational Methods; *Educational Technology; Elementary Secondary Education; *Hearing Impairments; Instructional Materials; Language Acquisition; Partial Hearing

ABSTRACT

This executive summary of a research synthesis on media, materials, and technology (MMT) which provide access to education for deaf and hard of hearing children from early childhood through eighth grade summarizes findings concerning: (1) assistive technology for education, including listening, visually based, and computer systems; (2) receptive skill development (audition and speech reading); (3) English language development and refinement; (4) media, materials, and technology for the development of American Sign Language; and (5) speech production teaching. (DB)

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National Center to Improve the Tools of Educators

College of Education
University of Oregon

Executive Summary of Research Synthesis on Design of Effective Media, Materials and Technology for Deaf and Hard-of-Hearing Students

EC304240

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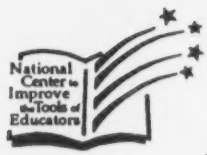

Technical Report No. 2 produced for the National Center to Improve the Tools of Educators, University of Oregon

Funded by the U.S. Office of Special Education Programs

Executive Summary of Research Synthesis on Design of Effective Media, Materials and Technology for Deaf and Hard-of-Hearing Students

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December 29, 1993

National Center to Improve the Quality of Technology,

Media and Materials: Research Synthesis

Design of effective media, materials and technology

for deaf and hard-of-hearing students

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Executive Summary

The purpose of this research synthesis is to review and summarize research findings and descriptive articles pertaining to media, materials and technology (MMT) which provide access to education of deaf and hard-of-hearing children from early childhood through eighth grade. The goal of the research synthesis is to use research findings and expert opinion to present guidelines and criteria for what constitutes optimal tools for this purpose.

The research synthesis deals with the following areas:

1. Assistive technology for education, including listening, visually based, and computer systems
2. English language development and enhancement
3. Development and educational use of American Sign Language (ASL)
4. Speech development
5. Receptive skill development (audition and speechreading)
6. Communication strategies
7. Orientation and training to use hearing aids, assistive listening devices and cochlear implants.

For each area, criteria and guidelines for optimal tools, critique of existing materials, and developmental needs are discussed. Limitations and restrictions of the research are also discussed in each section.

The research synthesis does not include media, materials and technology pertaining to parent education, use of interpreters, and curricular areas such as math, reading, social studies, science, music, art, health education, drug and sex education. Media, materials and technology for deaf adult learners, postsecondary instruction, vocational education, transitional programs, and adolescent substance abuse programs are not included. Materials to develop manually coded English and Cued Speech are also not included.

The target population includes all deaf and hard-of-hearing children from preschool through grade 8 with prelingual and later onset of hearing loss ranging from mild to profound. The document is relevant to manual, oral, English and ASL communicators and applicable to oral, total communication, bilingual/bicultural (ASL), Cued Speech, self contained and mainstreamed programs.

The research syntheses were based on computer searches of data bases covering the period from January, 1981 to June, 1993, including CATS, ERIC, Dissertation Abstracts, Washington Research Library Consortium, Periodical Indexes, and Newspaper Abstracts. Computer and manual searches of the following periodicals were conducted: Volta Review, American Annals of the Deaf, Journal of the Academy of Rehabilitative Audiology, Gallaudet Deafness Collection, Perspectives in Education and Deafness, Educational Technology, Educational Technology Research and Development, Computer and Education Journal, The Computer Resource Quarterly for People with Disabilities, and other selected curricula and books. In addition to these sources, the syntheses draw from the research and clinical experience of the authors as well as contact with selected individuals, currently working with deaf children.

ASSISTIVE TECHNOLOGY FOR EDUCATION

The following general considerations for development of quality visual or auditory MMT for deaf and hard-of-hearing children appeared in the few documents that were found:

1. Information should be presented in picture or graphic form whenever feasible. Text should be kept to a minimum.
2. MMT should be developed that is specifically for deaf and hard-of-hearing children, rather than adapting technology developed for hearing children.
3. MMT that schools can afford should be developed.

Visual Technology

Apple microcomputers and associated software are used in the vast majority of programs for deaf and hard-of-hearing children. Very few software programs, however, are designed specifically for deaf or hard-of-hearing children and those that are, are not necessarily more effective that adapted programs. Continued development of educational software programs for deaf and hard-of-hearing children is needed, with more use of IBM computers. Captioning systems need to be more user-friendly, with more open-caption software programs designed for use by students. Teachers report that successful software is characterized by the following features:

1. A game-like format with high-resolution graphic displays to motivate students
2. Graphic reinforcement for correct answers rather than word displays (eg. clown jumping and clapping)
3. Positive feedback to correct mistakes (eg. "try again")
4. Minimum amounts of text
5. All auditory features accompanied by visual components (eg. graphic display)
6. Menu-driven programs should to lessen the need for adult involvement
7. Extensive use of visual prompts
8. Foolproof keying so that hitting the wrong key will not cause the program to re-boot or exit the document
9. Flexibility so that the same program can be used for a variety of subjects and at different levels of difficulty.
10. Modifiability of programs (eg. ability to add specific vocabulary)

Use of computer assisted notetaking as an educational tool for large group applications where notes are being projected onto a screen should be increased. More word processing programs are needed with large font sizes and the ability to change sizes and fonts. User-friendly keyboard expansion software programs, quieter keyboards, quieter overhead projectors, and overhead projectors that work well when the lights are on are also needed.

Increased use of interactive video is desirable. Additional captioned educational videodisc programs should be developed using multimedia environments. Digital equipment

needs to be made available at affordable prices, including tools for creating multimedia captions.

Auditory Technology

Induction loop systems are being used in educational settings, but are limited by spillover problems. Oval Window Audio has developed the 3-D Induction loop system to minimize this problem. Development of such innovative products should continue. Standards for induction loop systems and hearing aid telecoils are needed.

FM systems are the most widely used auditory technology used in education. They should contain the following features:

1. Individual controls for adjusting frequency response and output of system.
2. Auxiliary microphone input capabilities for movie projectors, multiple microphones, and other sources.
3. Binaural reception
4. Easy to see and read low battery indicators
5. A switch allowing for selection of environmental microphone alone or teacher's microphone alone.
6. Directional microphone for the teacher
7. Voice-activated microphone mixing system for multiple speaker situations
8. Ability to switch between carrier frequencies on both receiver and transmitter
9. Automatic recharging and shut-off capabilities when in the storage/charging unit.
10. Ability to operate with a disposable 9-volt as well as a rechargeable battery.

Soundfield amplification systems have been found to be useful in the classroom as supplemental listening systems to enhance the signal/noise ratio. They can be used for hearing, hard-of-hearing, and learning disabled children and are significantly less expensive than individual FM units. However, they cannot guarantee the fidelity provided by the personal FM system, which should be the technology of choice for children with severe to profound hearing loss.

RECEPTIVE SKILL DEVELOPMENT

This synthesis deals with deaf and hard-of-hearing children. Not included are children with central auditory processing disorders, auditory learning disabilities, deaf-blindness or other disabilities in addition to deafness.

Although review of the literature revealed essentially no research data on guidelines and criteria for MMT, there was a considerable amount of discussion based on expert opinion. The following discussion and recommendations are based largely on this expert opinion.

Auditory Skills

Auditory training programs should include activities to develop skills in the following areas: detection, localization, selective attention, memory/sequencing, discrimination of suprasegmental and segmental speech features, closed-set and open-set identification of speech and environmental sounds, comprehension, figure-ground skills, voice monitoring, and use of suprasegmental information.

Both analytic and synthetic activities should be included, but the focus should be on language based activities using real life situations. Auditory training activities should be integrated with language training, speech production and speechreading. Some activities may be unimodal but audiovisual integration should be a priority. Discrimination training, especially activities using non-linguistic materials, should be minimized.

All activities should be interactive, meaningful, intrinsically rewarding, provide for individual adaptation, and allow for expansion and remediation strategies, as needed. Curricula and programs should include assessment procedures and provide individual programming.

All auditory training activities are predicated on the proper use of hearing aids. Therefore, all auditory skills curricula should include hearing aid orientation activities which teach parents and children realistic expectations of their hearing aids, how the hearing aid functions, proper use and care, ability to perform daily visual and listening hearing aid checks, and ability to troubleshoot malfunctions.

Similarly, curricula need to include orientation to assistive listening systems, particularly FM. There is a need to incorporate objectives and activities into school curricula and a need for studies evaluating the benefits of such training.

Although most schools for deaf and hard-of-hearing children have developed auditory skills curricula, several of which have been disseminated, for the most part these curricula use an analytic, bottom-up approach. There is a need for synthetic, language and situation based programs suitable for natural conversational or language experience approaches in the classroom, using materials that are suitable for the language competence and interests of a wide range of children. Simulated or actual real life situations need to be utilized to a much greater extent than currently exists.

Although most auditory skills curricula contain hearing aid orientation objectives and activities, there is a notable absence of orientation and training materials for assistive devices and cochlear implants. Only one comprehensive cochlear implant curriculum for adults (Cochlear Corporation) was found and this is not readily available to schools. Aural rehabilitation is essential to the successful use of the increasing numbers of cochlear implants being fitted to deaf children. Comprehensive training programs incorporating orientation activities, top-down and bottom-up auditory and audiovisual training integrated with speech production activities are needed. Of particular importance are materials to help families and children develop realistic expectations of the benefits of cochlear implants.

Voice telephone and TTY training involve auditory skills, speech production, language skills, communication strategies, use of assistive devices, and informational counseling. Although several curricula have been developed for adults, only one program for elementary school children has been identified. This program does not contain speech production activities nor instruction in use of third party relay systems. Telephone training curricula, in print and interactive video form, are needed for children.

Speechreading and Communication Strategies

Speechreading programs for children should also be primarily language based, using meaningful real life experiences. Speechreading should be integrated with auditory, receptive and expressive communication strategies training. Programs should include training in assertive behavior and conversational strategies. Although several top-down curricula have been developed and disseminated by the Pre-college programs at Gallaudet University, there is need for additional curricula incorporating a synthetic, interactive, integrative focus.

Connective discourse tracking is an excellent activitity for developing speechreading, audiovisual, and communication strategies skills. It can also be used to improve speech intelligibility. There is need for development of age and language appropriate tracking materials for children.

Interactive videodisc technology can be used for auditory skills, speechreading, and communication strategies training. It is interactive, highly motivating, can provide immediate feedback, and can individualize instruction by tailoring stimulus presentation to the child's responses. Tye-Murray and colleagues have developed several videodisc programs for children which contain both analytic (bottom-up) and synthetic (top-down) programs. There is need for additional programs which focus on real life situations. Much of the printed curricular materials, including tracking activities, can be adapted to video technology.

ENGLISH LANGUAGE DEVELOPMENT AND REFINEMENT

In order to effectively use the linguistic code of English, the language learner must have knowledge and expertise in the areas of:

1. Semantics or meaning (eg. vocabulary, figurative or nonliteral language)
2. Syntax and morphology (word order/grammatical information)
3. Phonology (sounds)
4. Pragmatics or the appropriate use of language. This includes the ability to get or give information, use the conventions of conversations such as initiation or termination of a topic of conversation, and provide sufficient information to a conversational partner to assure understanding of the message (taking the perspective of the receiver).

Children learn the various aspects of language through interaction with a primary caretaker through natural play and daily routines. Lack of auditory input provides incomplete access to the form of language and may effect the ease with which pragmatic aspects of English are learned. Children with hearing loss need to be given continuous opportunities to participate and use language through communicative interaction with others in their environment. At the same time, they may need structured assistance in refining specific areas of language.

Materials are reviewed in the synthesis which are representative of the available programs currently used with deaf and hard-of-hearing children. Reading curricula, language materials used for teaching content information, and MMT used for training memory, problem-solving, inferencing, etc. are not included.

The most commonly used materials for parent-infant work are the SKI-HI materials developed at the University of Utah. The program includes screening, referral, diagnosis, psychosocial support for parents, and parental language facilitation skill development in the home. Although longitudinal research in the efficacy of this program is in process, no published research is available. The results of needed programmatic research in the field of language development of deaf children should play an active role in the development of new materials.

Programs for school-age deaf and hard-of-hearing children tend to focus on a structural approach to written English in contrast to the focus on natural verbal language at the preschool level. Teacher emphasize specific skill areas, particularly syntax and grammar, at the school level. The Apple Tree program is reported to be widely used as an instructional language guide. Few programs in the areas of vocabulary and figurative language have been designed for children with hearing loss.

Programs to teach semantics are needed which are flexible in terms of complexity, cultural differences, interest level, and current experience. Children should not be expected to master many different figurative expressions in a short period of time.

Computer assisted instruction (CAI) is being used for drill, practice and tutorials. In addition, it can be used for simulation of real life situations, problem solving activities, exploration and discovery activities, and instructional games which sharpen note-taking abilities, ability to follow directions, hypothesis testing, and cause-effect relationships. Videodisc technology and hypermedia learning which uses materials that access multiple senses, facilitate language programming. Several interactive computerized programs for children loss are reviewed:

1. ALPHA system which emphasizes exploratory learning. The child is able to initiate communication with a teacher about a topic of interest.
2. Programs at the California School for the Deaf at Riverside designed to improve students' understanding of language structures, improve skills in sequencing events, and build vocabulary.
3. The ENFI (Electronic Networks for Interaction) gives deaf students at Gallaudet opportunities to use written English in different ways by engaging in real-time computer dialogues.

Following are recommendations for future development of MMT for English language development of children with hearing loss:

1. There is little definition in the literature nor understanding of the best way to develop English in deaf and hard of hearing children. Therefore, program developers need to work closely with researchers to identify the most important elements and ways to use MMT.
2. Programs need to identify the model on which they are based.
3. Evaluation procedures need to be built into programs.
4. Programs should be broad in scope rather than limited to only one aspect of language.
5. Focus should be on a conversational-interactive-functional approach in which children are involved in dynamic communication.
6. Age and interest-appropriate materials are needed, including materials representing experiences specific to deaf children and reflecting cultural differences. Materials need to reflect a range of developmental levels.
7. Materials need to be integrated into the regular curriculum and classroom activities.
8. MMT for children with hearing loss should rely heavily on visual input.
9. Programmed instruction at the written level should maximize interaction. Network based programs facilitate social interaction.
10. Most technological programs are being used with school-age children. MMT are needed for younger children.

11. Programs should be designed to be modifiable over time to reflect new insights into language development.

MEDIA, MATERIALS, AND TECHNOLOGY FOR THE DEVELOPMENT OF ASL

This section reviews existing media, materials and technology related to the teaching of ASL to children with hearing loss. MMT related to English signing systems, Cued Speech, and the use of sign language interpreters in education are not included.

There are materials that teach ASL to non-native users as a second language and other materials that teach English as a second language to students already proficient in ASL. However, there is a dearth of curricula, media, materials and technology for developing ASL as a first language. The document "Unlocking the Curriculum: Principles for Achieving Access in Deaf Education" proposes a model for teaching ASL as a first language during early childhood and later teaching English as a second language in written form. Early communication occurs exclusively through sign language, with literacy in English occurring during later childhood. Students learn to speak and speechread at the time they develop English literacy. MMT that are recommended as part of this model include:

1. Videotapes for sign language training directed toward both parents and children
2. Print materials for reading readiness, reading and writing
3. Companion print and captioned video materials to accompany standard grade level content sources
4. Video materials on deaf people and their way of life
5. Print and non-print materials for teaching English as a second language
6. Print and non-print materials for teaching ASL arts
7. Interactive videodisc-computer technology for the provision of comparative ASL and English passages.

Although three bilingual-bicultural programs (ASL as a first language) exist in the United States, it is too early to tell if they are proving any more successful than other types of educational programming. More program evaluation is needed.

The most promising materials to date are those using interactive video learning and videotape series that attempt to develop all aspects of ASL, not merely lists of vocabulary.

The most effective materials are those that encourage interaction with users of ASL, either between adult language users and deaf children or between deaf children themselves.

Materials and technology that encourage family members to interact with adult language models are needed. Videotapes and interactive computer programs for home use should focus on whole language learning rather than only vocabulary, and should provide information to hearing family members about how to get a deaf child's attention, how to interact visually, and how to recognize stages of ASL acquisition in their children. The use of interactive video-conferencing technologies may make it possible for deaf children to acquire ASL from native signers more effectively.

SPEECH PRODUCTION TEACHING

Sensory information plays a key role in speech acquisition by permitting development of models and providing feedback to mediate speech change. For many deaf children, audition is too limited to be adequate as the primary source of feedback; they require alternate sensory information. Although studies examining the overall efficacy of existing computer-based speech teaching systems suggest their use contributes to speech improvement, more studies are needed to compare their use to more traditional approaches (eg. Ling).

A promising aspect of computer-based systems is their potential for independent drill and practice. This is important for many school programs because of reduced class time for speech development activities. While home use is an important application of these systems, safeguards must be taken to limit development of inappropriate speech behaviors resulting from drill and practice of incorrect patterns.

Tactile devices have been found useful for teaching prosodic production features such as intonation. Additional wearable devices need to be developed and evaluated as aids to speech monitoring.

Existing curricular texts, media, and supportive materials based on the Ling model need revision to incorporate our current understanding of speech learning by deaf children. Alternative or modified approaches to speech teaching with curricula, particularly those based on more top-down, synthetic, language-based teaching strategies, need to be described and developed.

Current technologies focus primarily on suprasegmentals and vowel production or on elicitation, automation, and some degree of generalization of targets. Speech teaching devices are needed that focus on consonant production and facilitation of linguistic use. Current systems are limited in the availability of cues used for development of carryover of skills taught; greater flexibility in presentation of cues is needed.

Results of needed basic research on the value of different forms of feedback need to be incorporated in speech training devices. Although provision of feedback is the primary feature of many devices, in most cases they lack flexibility in controlling feedback parameters. Basic evaluation of tactile and visual feedback devices is needed to determine for which speech skill areas each type of system is most useful.

More clinical efficacy studies on commonly-used commercially available systems are needed, including efficacy of programs using combinations of existing technologies. Such studies should be child-centered rather than device-centered, since speech production training needs vary with individual children.